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a dedicated issue:

DIRECTORY OF EUROPEAN RESEARCH FACILITIES FOR THE CONDENSED MATTER AND MATERIALS SCIENCES

a report

by Dean L. Mitchell

Office of Naval Research European Office

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The purpose of this directory is to provide research investigators with information on specialized or unique facilities in Europe that could be useful in their research. The basic information from each laboratory include a description of: special or unique instrumentation; typical experiments, calculations, or data searches suited to the facility; description of the modes for carrying out research including requirements for access, funding requirements, scheduling policies; and the name or title, address, and telephone number of a person to contact for further information. The solicited laboratories provided the information in this guide on a voluntary basis.

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Editor .... Ms. Connie R. Orendorf

This special issue of ESNIB has been compiled by Dr. Dean L. Mitchell. Dr. Mitchell is the Liaison Scientist for Solid-State Physics in Europe and the Middle East for the Office of Naval Research European Office.

DIRECTORY OF EUROPEAN RESEARCH FACILITIES FOR THE CONDENSED MATTER AND MATERIALS SCIENCES .... Dean L. Mitchell

LIST OF TABLES

DIRECTORY OF EUROPEAN RESEARCH FACILITIES FOR THE CONDENSED MATTER AND MATERIALS SCIENCES

including

HIGH-FIELD MAGNETS
HIGH-FLUX NEUTRON SOURCES
SYNCHROTRON RADIATION SOURCES

by Dean L. Mitchell, the Liaison Scientist for Solid-State Physics in Europe and the Middle East for the Office of Naval Research European Office.

Introduction

The purpose of this directory is to provide research investigators with information on specialized or unique facilities in Europe that could be useful in their research. The "Directory of Multidisciplinary User Facilities" published by the National Science Foundation (NSF 84-7) is the model for this directory. The information provided here supplements the following publications: Directory of Multidisciplinary User Facilities (NSF), "National Facilities for Research in the Physics of Condensed Matter" by George H. Vineyard and L.M. Falicov published in Review of Scientific Instruments No. 55,620 (1984), and "Scientific User Facilities - A National Resource" published by The Office of Basic Energy Sciences of the Department of Energy..

The basic information requested from each laboratory included a description of: special or unique instrumentation; typical experiments, calculations, or data searches suited to the facility; description of the modes for carrying out research including requirements for access, funding requirements, scheduling policies; and the name or title, address, and telephone number of a person to contact for further information.

The solicited laboratories provided the information in this guide on a voluntary basis. These laboratories are mainly involved in research requiring high magnetic fields, synchrotron radiation, or high-flux neutron sources. Not all laboratories responded; also, not all facilities may have been solicited. Hence, this guide is offered as a first stage in the development of a more comprehensive, and perhaps, more useful guide to European facilities.

Note to Users: Telephone numbers in this guide are given in the following format: (A-{0}B)C where A is the country code; B is the city code with a 0 added when dialing within the country as indicated by {0}; and, C is the telephone number written XXX-XXXX for seven digit numbers and XX XX XX for all others.

HIGH MAGNETIC FIELD FACILITIES

Amsterdam High Magnetic Field Laboratory Amsterdam, The Netherlands

The 40 Tesla magnet is part of the physics laboratory of the University of Amsterdam. This laboratory has solid-state physics as the main research area with specialized groups on intermetallic compounds, semi-conductor physics and condensed matter spectroscopy. The magnet has been developed especially for measurements on metallic systems. Its unique feature is the fully controllable field versus time profile. Standard measurements consist usually of a series of six or seven field-values that can be kept constant (within 10^{-4}) for a time as long as 100 ms. This time is much longer than the typical relaxation time for eddy-currents in metallic systems and allows time therefore to eliminate any eddy-current contributions from the measured signal.

For optimum temperature stability, the measurements are usually performed in cryogenic liquid (liquid He, H_2, Ne or N_2). Within certain limits, the temperature can be tuned by controlling the pressure. A flow cryostat that will extend the complete temperature range from 1.5 K to room temperature is under construction.

Measuring techniques have been developed for magnetization, magnetoresistance, Hall-effect, and critical-current-density experiments. With a special technique, dHVA measurements can be performed. Other measuring techniques can relatively easily be installed because of the long pulse-time of about 1 second. A 60 Tesla installation is planned.

The magnet is not a standard user facility but can be used by users from outside the laboratory on the basis of collaborative research with the in-house physicists. For further information contact:

Dr. F.R. de Boer
Natuurkundig Laboratorium
University of Amsterdam
Valckeniersstraat 65
1018 XE Amsterdam
The Netherlands
Telephone: (31-20) 525-5663
Telefax: (31-20) 525-5788
E-mail: FRINGS@SARA.NL (Bitnet)

Grenoble High Magnetic Field Laboratory Grenoble, France

The Grenoble High Magnetic Field Laboratory is run jointly by the French Centre National de la Recherche Scientifique (CNRS) and the German Max Planck Institut für Festkörperforschung (MPI).

The magnetic laboratory's facilities are, in principle, available free of charge to all qualified users meeting the usually accepted quality standards. The laboratory does not usually furnish travel and living expenses. A European Community (EC) contract will make possible limited support for visitors from EC countries. A variety of high-field magnets are provided, together with cryogenic, measurement, and data processing instrumentation. An experienced support staff is available on a full-time basis to aid visitors with all aspects of their experiment. Consulting is provided by the research staff at the laboratory for most problems.

The laboratory features a variety of dc-magnets; e.g., very homogeneous, radial access, and big volume with fields up to 31T in a bore of 5cm. Visitors should discuss the use of the magnet appropriate to their experiment with their local contact. Typical examples of general purpose equipment and apparatus available to users are listed in Table 1.

Table 1. General Purpose Instrumentation

- General Purpose Electronics:
  - Oscilloscopes
  - Recorders
  - Voltmeters
  - Amplifier
  - ac-Sources
  - dc-Power Supplies
  - Phase-Sensitive Detectors
- On-Line Digital Equipment and Microcomputers
- Low-Temperature Systems (1.5-300K)
  - Metal Cryostats
  - Pumping Equipment
  - Pressure Regulators and Readouts
  - Variable-Temperature Sample Holders (Special Design) Including Appropriate Thermometry
- Helium-3 and Dilution Refrigerators Adapted to High-Field Use.

Specialized experimental setups available to users are listed in Table 2.

Table 2. Specialized Experimental Setups

- Magnetization Measurements
- De Haas-van Alphen Spectroscopy
- Point-Contact Spectroscopy
- Magnetotransport
- Low Temperature Specific Heat
- Far-Infrared (FIR) Spectroscopy
- Magneto-Optics in the Visible and Near Infrared (IR)
- Electron Spin Resonance (ESR) Spectroscopy
- Gas Phase Molecular Optical Spectroscopy
- Magnetic Birefringence
- Elastic and Quasi-Elastic Light Scattering
- Fringe Pattern Fluorescence Bleaching in Magnetic Fields.

Persons interested in using the laboratory's facilities should submit a research proposal on the forms available from the laboratory. A committee reviews the submitted proposal and may accept, modify, postpone, or reject it. At present, there is a queue with waiting times from 1 week to 4 months. Acceptance requires an agreement with a local contact who will provide all help needed from the laboratory. No experiment-related fees are charged to the scientific and noncommercial user. The facility runs 24 hours per day, including weekends and holidays, except during a few annual shut-down periods for maintenance, tests, and repairs. In addition, the laboratory shuts down for a total of 22 so-called *EJP-days* between November 1 and March 31. The local electricity supplier defines these *EJP-days* 1 day in advance. For the annual report, the laboratory requests a progress report within the 6 months after completing the experiment. Finally, any publication containing results from the laboratory should properly refer to the Grenoble High Magnetic Field Laboratory.

For more information, contact:

Director,
Grenoble High Magnetic Field Laboratory
CNRS and MPI
B.P. 166 X
F - 38042 Grenoble Cedex
France

Telephone:	(33-76) 87 98 42
	(33-76) 88 10 01
Telefax:	(33-76) 87 21 97
Telex:	320823

Nijmegen High-Field Magnet Laboratory
University of Nijmegen, Nijmegen, The Netherlands

The Nijmegen High-Field Magnet Laboratory (NHFML) is a university sponsored facility which welcomes guest scientists. The laboratory operates a 6-MW power supply to the water-cooled magnets in five magnet stations, with the magnets ranging from a 60-mm diameter 15-T Bitter coil to a 32-mm diameter 30-T hybrid magnet system.

Magnet stations at the NHFML.

Magnet system	B_{max}(T)	Bore(mm)
1. Hybrid magnet N-1	25.0	53
2. Duplex Bitter coil	20.0	32
3. Bitter coil	15.2	60
4. Duplex Bitter coil	20.0	32
5. Hybrid magnet N-II	30.4	32

The emphasis of the in-house research is on the study of semiconductors, superconductive materials, and intermetallic compounds. A variety of cryogenic, spectroscopic, measurement, and data processing instrumentation are available on site:

- General purpose electronics
- IBM-compatible data-acquisition system
- Bath- and flow-cryostats fitting all the magnet systems
- ^{3}He inserts and ^{3}He/^{4}He-dilution-refrigerators
- FIR lasers and a (picosecond-pulsed) optical laser
- FIR Michelson interferometer and (F)IR Fast-Fourier Transform (FFT) spectrometer
- Standard inserts for a variety of different experiments.

Some sponsoring from national and European sources is available which eases access of guest-scientists and will assure a reasonable level of aid to these outside users. Travel and living expenses are in general not furnished by the laboratory.

The assignment of magnet time occurs usually within weeks of request. Scheduling of the hybrid magnet runtime will be done in close contact with all parties involved and only if lower-field data clearly prove the need. Access to the magnet facility is obtained by contacting the Solid-State Physics Department (Professors H. van Kempen, A.R. de Vroomen, and L.J. Giling), or by applying to:

Dr. Jos A.A.J. Perenboom
Manager, High-Field Magnet Laboratory
University of Nijmegen
Toernooiveld
NL-6525 ED Nijmegen
The Netherlands
Telephone: (31-80) 61 33 03
Telefax: (31-80) 55 34 50
Telex: 48228 WINA NL

High Magnetic Field Facility, Clarendon Laboratory
University of Oxford, Oxford, United Kingdom

The High Magnetic Field Facility, Clarendon Laboratory, has been in operation since the years immediately following World War II. The facility has developed over the last 40 years into the principal high magnetic field research establishment in the U.K.

The basic power source is a 2.5-MW motor-generator set which energizes a range of water-cooled solenoids giving maximum magnetic fields of 9 to 13.5T in room temperature bores of 50 or 30mm. Shortly, the facility will have two "hybrid" magnets (combinations of water cooled and superconducting magnets). One of these has been in operation for 17 years and produces about 16T (50-mm bore) and 20T (30-mm bore). The second hybrid is scheduled for commissioning in Autumn 1990. This will produce about 24T in a 30-mm bore and about 20T in a 50-mm bore.

Over the last 5 years, pulsed-magnet technology has been developed. The facility is now being equipped with a pulsed-magnet laboratory which will initially produce fields of up to 60T for pulse lengths of about 10-ms. Later

it is hoped to increase both field level and pulse length. This system should be in operation within 2 years.

The high-field facility is primarily used by the condensed matter physics community in Oxford. Many visitors also use the system. Previously, these visitors have usually been guests of individual researchers or groups. However, the strong upgrade and refurbishment program that is in progress, will make it increasingly possible to extend the facilities to external users.

At the Clarendon Laboratory, an extensive range of peripheral equipment, typical of a physics laboratory specializing in low temperature solid-state research, can be made available.

The financial arrangements to cover using the various systems will vary depending on the user's affiliation and the purpose of the work. For more information, contact:

Mr. H. Jones
Clarendon Laboratory
Parks Road
Oxford OX1 3PU
United Kingdom
Telephone: (44-{0}865) 27 23 26
Telefax: (44-{0}865) 27 24 00

Toulouse Facility for High Magnetic Fields Toulouse, France

The Toulouse Facility for High Magnetic Fields was established in 1973 and became fully operational for research in 1976. The CNRS sponsors the laboratory and provides support to make the quasi-static magnetic fields available to researchers from France and other countries.

At present, pulsed fields of 43T and 46T with durations of a second are available. These fields are produced by copper coils which are cooled by pumped-over liquid nitrogen before each pulse. Peak fields of 60T with same duration are expected to be operational in 1992.

Realization of a 46-T magnet with a pulse length of a second has allowed Toulouse to reclaim leadership for long-pulse magnets. These capabilities have recently been extended by the successful generation of 61-T pulsed fields with durations of a quarter of a second. The latter field is produced by a copper-composite coil with the windings reinforced by filaments of NbTi.

A "crowbar" technique, developed at Toulouse, makes possible an economical method for extending pulse lengths to maintain fields above 30T for longer periods. A pulse length of one second is usually sufficient to carry out measurements with a quality comparable with dc fields. Such experiments have been used to characterize materials and to investigate fundamental condensed matter phenomena for a diverse range of materials.

At Toulouse, researchers have access to reliable pulsed magnets situated in five experimental stations. Four of the stations are instrumented for transport and magnetization experiments. The fifth station is instrumented for magneto-optical experiments in the infrared (IR). Experiments may be accomplished over a temperature range from 1.4K to 300K; lower temperatures, to 0.2K, will be available soon. The inside diameter of the coils is 26mm. By precooling these coils, 42T can be attained at 77K, and 43.2T can be attained at 63K.

At 1250kJ per pulse, the mean lifetime of a coil is 200 pulses. For a given coil, the lifetime depends on the thermal and mechanical stresses that are proportional to the magnetic pressure and to a coefficient dependent on the coil geometry. The configuration may be defined in terms of the parameters $\alpha = a_2/a_1$ and $\alpha = a_2/l$; where, $2l$ is the length of the coil, $2a_1$ is the inner diameter, and $2a_2$ is the outer diameter of the coil.

By making α large, the stresses on coils are minimized. This is one of the main criteria adopted at Toulouse for the design of coils. For example: with $\alpha = 3$, at 46T, the stresses exceed the limit of 140 kg/mm^2 and hence the coil would explode. Therefore, the coils at Toulouse are designed such that $\alpha > 10$.

The coil that produces 46T is very thick, $\alpha = 20$. The inside diameter was reduced to 11mm to increase reliability. Following 150 pulses, the stresses on the restraining band of the coil is subject to a force of 60 tons. Cross-sections of such coils are obtained following extended operation to determine the deformation of the inner windings. These studies provide valuable diagnostics on failure modes and help improve the design and fabrication of magnet coils.

Future improvements include developing reliable 60-T magnet coils using the copper-NbTi filament composites and developing a "crowbar" pulse generated for use with the new 10-MJ supply. The latter will be im-

Table 3. Typical Experiments

Insulators:
- Magnetization in Ferromagnets, Ferrimagnets, and Anti-ferromagnets
- IR Spin Resonance.

Semiconductors:
- Electronic Band Structure Studies Using:
  IR Cyclotron Resonance
  Oscillatory Magneto-Phonon Effect
  Shubnikov-de Haas Effect
- Polaron Studies in III-V/II-VI Semiconductors including High-Field "Stripping"
- Quantum Hall Effect & Oscillatory Magneto-Resistance in 2-D Electron Gas
- Magneto-Impurity Resonance Effects.
- Magnetic Properties of Semi-Magnetic Semiconductors

Metals:
- "Crystal Field" & Short-Range Order in Amorphous Metals
- Weak Localization in Strongly Disordered Alloys and Amorphous Alloys via Magneto-Resistance Experiments
- Magnetization and Magneto-Resistance in Spin Glasses.

Organic Conductors:
- Quantum Oscillations/"Nesting"/Order and Disorder of Anions
- Anisotropy & Dimensionality of Electronic Conduction
- Metal to Spin-Density-Wave Transition
- Localization effects.

High T_c Superconductors:
- Determination of H_{cr} by Magneto-Resistance and Magnetization Measurements
- Electronic Properties in the Normal State

plemented over the next two years, in a new two-room laboratory covering 2,000m^2 and will provide pulses of 6 second duration at 40T, 4 second duration at 50T, and 1 second duration at 60T. Typical experiments are listed in Table 3.

The in-house research investigators are members of the Laboratory of the Laboratoire de Physique des Solides, Toulouse. They are available to aid visiting investigators with the special techniques necessary to carry out experiments in pulsed magnetic fields.

For more information, contact:

Professor S. Askenazy
Service CNRS des Champs Magnétique Intense
Institut National des Sciences Apliquées
et Université Paul Sabatier
156, Ave de Rangueil
31077 Toulouse Cedex
France
Telephone: (33-61) 55 99 27 or 15
(33-61) 55 95 91 (Sect)
Telefax: (33-61) 55 96 24

MEDIUM AND HIGH-FLUX NEUTRON SOURCES

Laboratoire Léon Brillouin
CEN Saclay, Gif-sur-Yvette, France

The Laboratoire Léon Brillouin (LLB) is a national laboratory sponsored by the Commissariat à l'Energie Atomique (CEA) and the Centre National de la Recherche Scientifique (CNRS) for the use of the Orphée continuous neutron source. The laboratory carries out its own research program, cooperates with the French scientific community and is also opened to international collaborations. Its investigations by neutron scattering cover various topics such as physics, chemistry, metallurgy, and biology.

The medium-flux reactor Orphée has a thermal power of 14-MW and a maximum thermal neutron flux of $3 \times 10^{14} n\ cm^{-2}\ s^{-1}$. Two cold sources and one hot source allow the selection of the appropriate neutron energy spectrum.

There are 22 permanent spectrometers:

Elastic Instruments:

- 7 two-axis diffractometers including one equipped with polarized neutrons and a four-circle instrument
- 3 two-axis diffractometers dedicated to diffuse scattering in disordered systems.

Inelastic Spectrometers:

- 5 triple-axis spectrometers
- 1 time-of-flight spectrometer
- 1 spin-echo spectrometer.

Special Instruments:

- Small-angle scattering spectrometers
  4 spectrometers including 2 equipped with XY multidetectors
- Reflectometer
  1 equipped for studies of horizontal surfaces.

A complete list of instruments and performances is available on request.

Most of the spectometers are operated by means of PC-compatible microcomputers. However the three-axis spectrometers are controlled by Sun microcomputers and connected to a SUN-3 central workstation.

A committee of users and scientists set the basis for time sharing at the laboratory. The meetings take place once a year at fall: before agreement each project must be presented there by a representative of the research team (appropriate proposal forms can be obtained on request from the scientific secretary).

For further information, contact:

E. FRIES, Scientific Secretary
Laboratoire LÉON BRILLOUIN
CEN-SACLAY
91191 Gif-sur-Yvette Cedex
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Telephone: (33-1) 69 08 54 17
Telefax: (33-1) 69 08 82 61
Telex: ENERG 690641 F LBS

Institute Max von Laue-Paul Langevin Grenoble, France

The Institute Max von Laue-Paul Langevin (ILL) is a research facility for users mainly from the members: U.K., France, Federal Republic of Germany, Spain, and Switzerland. The facility is also open for scientists from other countries.

The central equipment is a high-flux beam reactor (maximum flux at 50 cm from the reactor core: $1.5x10^{15}/cm^2s$) providing neutron fluxes from 10^7 to $5x10^{10}/cm^2s$ at 50 beam ports. The ports are equipped with 35 permanent instruments:

- 3-axis and TOF spectrometers for inelastic scattering
- Powder and single crystal diffractometers for elastic scattering
- Small-angle scattering facilities
- Gamma and fission product spectrometers for nuclear physics.

There are also 15 temporary special facilities, which are not scheduled by the Scientific Council, but longer-term collaborations are welcome.

Each experimental station has Digital Equipment microcomputers. The central computer is a clustered VAX 8650/8700 providing a permanent archive for all experimental data; and facilities for data monitoring, correcting, and transcripting onto magnetic tape for the visitor to take to his home institute.

The duration of experiments varies between 1 day and several weeks. Normally, the reactor operates continuously during 6 cycles per year, 44 days each. The delay for accomplishing accepted projects may vary between 3 and 9 months.

The ILL user community is represented by eight Scientific Council subcommittees that meet biannually to select the research proposals to be given beamtime. The scientific areas of the experimental activity are Solid State Physics, Material Science, Chemistry, Biology, and Nuclear and Fundamental Physics.

Appropriate proposal forms can be obtained on request from the Scientific Coordination and Public Relations Office (SCAPRO). The SCAPRO also coordinates the adjudication procedure of about 1,200 projects yearly. University and governmental research centers have free use of ILL facilities. Industrial laboratories must obtain a beamtime rate from SCAPRO.

For further information, contact:

Dr. B. Maier - Scientific Secretary or
Dr. H. Blank
SCAPRO
Institut Max von Laue - Paul Langevin
156X
F-38042 Grenoble Cedex
France
Telephone: (33-76) 48 71 11
Telefax: (33-76) 48 39 06

ISIS Pulsed Neutron Scattering Facility Rutherford Appleton Laboratory, Didcot, United Kingdom

The ISIS pulsed spallation neutron source is the most powerful of its kind in the world. The facility has a variety of instruments that are used for condensed matter research by the U.K. academic community, a strong international group, and increasingly, industry.

The facility is based on a rapid cycling synchrotron that delivers 800-MeV protons to a depleted uranium target. High-energy neutrons created by the spallation process are then moderated to thermal energies by a set of small hydrogenous moderators (ambient water, 100K methane, and 25K hydrogen). The moderated source has a strong epithermal component, that, for the first time, gives access for condensed matter research to neutron energies of an electron volt and above. The design current of the accelerator is $200\mu A$ and at present it operates routinely at $100\mu A$.

Instruments at ISIS fall into two distinct classes:

- Elastic scattering instruments for determining the microscopic structure of materials by diffraction
- Inelastic spectrometers that give information on atomic motions and forces.

All instruments exploit the pulsed white-beam nature of the source and employ time-of-flight techniques. There are 12 scheduled neutron instruments and one muon facility. The potential exists for at least 18 independent neutron beamlines.

Elastic Instruments

The High-Resolution Powder Diffractometer (HRPD) has a very high-resolution ($5x10^{-4}\Delta d/d$) over a wide range of d-spacings. Primary uses:

- *Ab-initio* structure determinations
- Studies of large unit cells
- Subtle phase transitions mixed phase systems
- Line-broadening effects
- Structure determination in hydrogenous materials.

In addition, the HRPD can achieve single crystal quality data from powders.

POLARIS, the high-intensity powder diffractometer, is optimized for the study of materials under special sample environments such as high pressure. The resolution is still good at $5x10^{-3}$ $\Delta d/d$ and the intensity can be exploited to take snapshots of real-time processes or to investigate small or dilute systems.

The single crystal diffractometer (SXD) uses a 350x350 mm^2 area detector with the white beam to access large volumes of reciprocal space. The SXD is ideally suited for monitoring phase changes involving the appearance of superlattices or incommensurate peaks and/or for diffuse scattering studies.

The liquid and amorphous diffractometer (LAD) and its second generation replacement SANDALS are used in studying static structure factors in a wide range of fluid and amorphous systems. The LAD instrument has been particularly successful in exploiting hydrogen-deuterium and other isotope substitution techniques to determine pair correlation functions in aqueous solutions and simple organic liquids. The SANDALS station is optimized for measurements at low-momentum transfers, where troublesome inelasticity corrections are minimized.

Large-scale structures can be investigated by LOQ, the small-angle diffractometer. A particular feature of LOQ is its ability to measure simultaneously over a wide range of momentum transfer, allowing, for example, the time dependence of a precipitate growth in an alloy to be followed.

The neutron refractive index of surfaces is exploited by the neutron reflectometer CRISP to measure surface structure and interface phenomena. The instrument has a beam inclined at 1.5° to the horizontal which allows liquid surfaces and surface adsorption to be investigated. The magnetic dipole moment of the neutron also makes CRISP a sensitive probe of surface magnetism.

Inelastic Scattering

The design of the High-Energy Transfer (HET) spectrometer allows the exploitation of the rich epithermal spectrum unique to pulsed sources. Allowing the investigation of high-energy (10 to 2,000meV) inelastic processes at low associated momentum transfer, such as inelastic magnetic excitations in rare-earth and actinide systems. MARI, its sister spectrometer funded from Japan, provides a more extensive momentum transfer coverage of this energy range giving access to vibrational modes and momentum distributions.

The PRISMA spectrometer, constructed by CNR in Italy, measures coherent excitations, such as, phonons or magnons along high-symmetry directions in single crystals. The PRISMA's ability to measure simultaneously over a wide range of energy and momentum transfer allows complete dispersion relations to be determined in one setting.

The chemical spectroscopy instrument, TFXA, has excellent resolution $\Delta\varepsilon/\varepsilon$ of 1.5 percent in the molecular vibration energy range. TFXA is particularly adept at studying the dynamics of hydrogenous species.

The high-resolution inelastic spectrometer, IRIS, studies diffusion and tunneling phenomena in molecular species with energy resolutions of 15 and 5μeV. The wide energy and momentum transfer ranges accessible make ISIS unique.

In addition to neutrons, ISIS produces positive muons for condensed matter research using the muon spin resonance (μsR) technique. Negative muons are produced for studies in atomic physics and in the pursuit of muon catalyzed fusion.

All these instruments are supported by an extensive range of sample environment equipment: cryostats, furnaces, goniometers, magnets, and pressure cells. A unified computing service based on the VAX system supports the ISIS facility.

Proposals for beamtime at ISIS are accepted biannually (16 April and 16 October) and are subject to peer review. Necessary assistance with the experiment is provided through a local instrument scientist. There is no charge for beamtime but commercial rates are available for proprietary research (independent of peer review). For further information, contact:

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Risø National Laboratory
Roskilde, Denmark

Risø National Laboratory is the only national laboratory in Denmark; it was founded in 1956 and reports to the Danish Ministry of Energy. The research reactor DR3 at Risø is the only nuclear reactor in Denmark. In 1960, it became critical, and since then the staff in the Physics Department have been responsible for the neutron scattering instrumentation and the scientific activities at the reactor. The in-house staff consists of thirteen scientists, three to four Ph.D. students, and eleven technicians. The scientific activities are divided almost one to one between neutron scattering at DR3 and x-ray scattering using an in-house rotating anode x-ray source or x-rays produced by the synchrotron source at HASY-laboratory at DESY in Hamburg, Federal Republic of Germany. There is a long-standing tradition for extensive international cooperation. During 1989, about 40 scientists visited and took part in neutron or x-ray scattering experiments.

At present the neutron scattering facilities are used exclusively by the Risø staff and their collaborators who mostly come from outside Denmark. Travel and living expenses has in general not been furnished by the Laboratory. However, a proposal has been made in connection with the European Communities Large Facility Programme to open up a proportion of the neutron scattering facilities at the DR3 reactor to European users.

The DR3 reactor is a heavy-water-moderated, 10-MW thermal neutron research reactor. Neutron beams are available for materials research from two thermal and two cold beam ports in the Reactor Hall. One of the cold beams is shared with a 20-m long cold neutron guide-tube which provides three beam ports in a separate building, the Neutron House, with cold neutrons.

At any given time there are seven operating instruments at four beam channels. The instruments are multipurpose instruments of a modular design that allows the use of different detector configurations. Only three instruments (SANS, 4-circle, and a cold source triple-axis spectrometer) are dedicated to a specific mode of operation. The neutron scattering instruments are, to a large extent, standardized and share common features. The auxiliary equipment (furnaces, cryomagnets, cryostats) can in general be used at all instruments.

The available instrument configurations are the following:

- 2 Cold Source Triple-Axis Spectrometers
- 1 Cold or Thermal Source Triple-Axis Spectrometer
- 1 Cold Source Small-Angle Neutron Scattering Facility (SANS)
- 1 Cold Source Neutron Reflectometer
- 1 Thermal Source 4-Circle Diffractometer
- 1 Thermal or Cold Source Instrument with Different Detector Configurations
  - Two-Axis Tilting Detector
  - Multi-Detector for Power Diffraction
  - Position-Sensitive Detector for Texture Studies
  - Position-Sensitive Detector for Internal Strain Studies.

A complete description of the instruments is available on request.

Research projects proposed by scientists outside Risø can at the present be suggested to a neutron scattering staff member at Risø and may after a scientific review be carried out in cooperation with at least one staff member. Allocation of beamtime is usually decided about 8 days before the start of the period in question. Changes can often be made in the spectrometer allocation during the operating period, depending on the progress of the experiments. In joint projects with visitors from abroad, it is sometimes convenient to plan several months ahead. In this case, the staff member in charge of the experiment arranges a preliminary allocation. The allocation procedure will be changed if the neutron scattering facilities at DR3 becomes partly a European user facility.

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SYNCHROTRON RADIATION SOURCES

Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung mbH (BESSY) Berlin, Federal Republic of Germany

The BESSY facility operates mainly as a service institution. The storage ring injection system, beamlines, and monochromators are designed and operated by the staff. Developing this equipment is a major part of BESSY's task. However, some in-house research is also performed, mostly in accelerator physics, solid-state and surface physics, as well as applied optics. At present, BESSY has a full time staff of 63.

The storage ring operates each week from Monday through Friday in two shifts (16 hours daily). After deductions for machine maintenance, shutdowns, and machine studies, BESSY offers at least 2,400 hours net beamtime for users annually.

The Facility

The main parameters of the BESSY storage ring are given in Table 4. Typical performance data are: After injection up to 500mA, the beam lifetime is 2 to 3 hours and is dominated by the Touchek effect and wiggler gap. The horizontal emittance is $5x10^{-8}$ πmrad and the coupling is 1-10 percent depending on the exact mode of operation. At a typical source point the electron beam size is 0.5mm horizontal and 0.3mm vertical (full-width, half-maximum). The characteristic photon energy E_c of the synchrotron radiation emitted from a bending magnet is 650eV.

Table 4. BESSY Machine Parameters

E_{max}	800MeV
B_{max} (Dipole)	1.5T
P	1.778m
Circumference	62.4m
Number of magnets	
Dipoles	12
Quadrupoles	32
Sextupoles	16
Undulators	2
Horizontal emittance (var.)	$5x10^{-8}\pi$mrad
Bunch length	20-500ps
RF frequency	500/62.5MHz
λ_c	2nm
Beam current	100- 500mA

Most of the 23 monochromators in the basic research area belong to BESSY and are maintained by the staff (see Table 5). Usually, either the exit slit of the monochromator or the connecting flange behind a refocusing mirror is the user interface. The user provides the experimental chamber and associated equipment. However, several so-called common facilities exist (particularly for photoemission and surface extended x-ray absorption fine structure [SEXAFS and EXAFS] experiments).

Table 5. Monochromators for Basic Research

Name	Type	Wavelength Range (nm)
1m NIM 2	15°-Rowland Circle	40-300
3m NIM 1 and 2	4.5°-Rowland Circle	40-640
6.5m NIM	Monk Gillieson - PGM	40-675
Wadsworth 2 and 3	Modified Wadsworth	40-300
1m-Seya	1m Seya-Namioka	30-200
2m-Seya	2m Seya-Namioka	25-240
TGM 1, 4, and 7	2.1m Toroidal-Grating Monochromator (146°)	10-200
TGM 2 and 3	4.1m Toroidal-Grating Monochromator (162°)	6-150
TGM 5	16m Toroidal-Grating Monochromator (168°-154°)	4-120
TGM 6	4.7m Toroidal-Grating Monochromator (145°)	10-100
BMW-SGM	5.0m Variable-Angle Spherical-Grating Monochromator	4-40
SX-700I, III, and IV	Plane-Grating Monochromator	0.6-50
HE-PGM II	Plane-Grating Monochromator	0.6-13
HE-TGM I	16.3m Toroidal-Grating Monochromator (172°)	0.9-13
HE-TGM 2	9.2m Toroidal-Grating Monochromator (170°)	1.7-11.3
KMC	Double-Crystal Monochromator	0.25-1.1

European Synchrotron Radiation Facility Grenoble, France

The European Synchrotron Radiation Facility (ESRF) is supported by 12 European countries. Funds have been provided to build and operate a 6-GeV electron (or positron) storage ring, which will be a dedicated, high-brilliance source of synchrotron radiation. Operation for users is scheduled for 1994. The ESRF storage ring will have a low-emittance Chasman-Green magnetic lattice with 32 achromats and 29 straight sections, each 6-m long, available for insertion devices (undulators and wigglers). The storage ring will also have 27 usable bending magnet ports. The circumference of the machine will be about 850m and it is designed to operate at a nominal current in excess of 100mA, with an exponential lifetime exceeding 10 hours.

The critical energy of the ESRF bending magnet sources is 19.2keV and the undulators are expected to deliver brilliancies in excess of 10^{17} photons/s mm^2 $mrad^2$ per 0.1 percent bandwidth, in a range of tunability between 2 and 20keV, encompassing the first, third, and fifth harmonic.

Present scientific plans foresee facility beamlines with the following goals:

- Microfocus diffraction and small-angle scattering
- Inorganic crystallography
- Laue protein crystallography
- Real-time small-angle scattering
- High-energy x-ray scattering (E > 30keV)
- Circularly polarized photons in absorption and photoemission
- Surface diffraction
- Dispersive and energy-scanning EXAFS
- Mössbauer diffraction
- High-resolution inelastic scattering
- Magnetic scattering
- Microtomography
- X-ray topography.

For external users, the ESRF will build and operate 30 facility beamlines, most of which exploit insertion devices as sources. The beamlines will cover all major scientific applications of hard x-rays in condensed matter and surface physics, materials science, chemistry, biology, earth, and planetary sciences. This instrumentation will be free to nonproprietary users from the participating countries, based on scientific merit. Proposals of exceptional scientific interest by scientists working in nonmember countries are also welcome.

In addition to the facility beamlines, other beamlines or additional instruments may be implemented by groups of users, each with its own resources and planned experimental effort. Access to these instruments will also be possible to external individual users for a fraction of the total beamtime.

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Laboratoire pour l'Utilization du Rayonnement Electromagnétique (LURE) Orsay-Université Paris-Sud, France

Located 20 km south of Paris, LURE is the French National Synchrotron Radiation Center. Activities are in-house research and development in addition to services for guest groups. We use the synchrotron radiation emitted by two storage rings, Super ACO and D.C.I. In addition, a linear accelerator free electron laser (CLIO) to work in the range 2-30μ is under construction.

Super ACO

E = 800 Mev (e^+) - First operation in 1987
4 insertions devices (6 possible)
Number of bunches : 1 - 24

Max current I :	700 mA in 24 bunches
	220 mA in 2 stable bunches
Emittance:	$\varepsilon_x = 3.7\text{x}10^{-8}$ mrad
	$\varepsilon_z = 2\text{x}10^{-9}$ mrad

Lifetime: at 400 mA, 3.5 hours for 24 bunches. In 2 bunches, the 100 mA, 12 hour lifetime is about halved.

We have 22 experiments around the storage ring (see Table 8). Fifty percent of the shifts are in 2-bunch mode.

D.C.I.

E = 1.85 GeV (e^+) - First operation in 1976
1 Superconductive wiggler (5 T)
Number of bunches: 1
Maximum current: I = 300 mA
Lifetime at 300 mA: 60 hours
Emittance: $\varepsilon_x = 1x10^{-6}$ mrad
$\varepsilon_y = 1x10^{-7}$ mrad
0 Wiggler (5 Tesla)

We have 20 experiments around the storage ring (see Table 9).

Staff

The staff at LURE includes:

41 Permanent scientists (physicists, biologists, chemists)

41 Associated (belonging to the laboratories of the Orsay Campus)

21 Foreign postdocs

20 Students, doing research for theses

200 Engineers, technicians, administrators.

Table 8. SUPER ACO

Line	Monochromator		Experiment
SU6 (undulator)	T.G.M.	10-140 eV	a) Angle-Resolved Photoemission (Solids) b) Photoemission of Multicharged Ions c) Clusters
SB6	2-crystal	0.8-5 keV	Lithography
SA6	a) Normal incidence b) Normal incidence c) 2-crystal	5 - 40 eV 5 - 40 eV 0.8 - 5 keV	Photoionization - Coincidence (Molecular Physics) Absorption
SU7 (undulator)	a) b) T.G.M. c) T.G.M.	 5-50 eV 0.1 - 1 keV	Free Electron Laser Harmonic G eneration Absorption and Photoemission Holography Photoemission (Molecular Physics)
SA7	a) T.G.M. b) 2-crystal c) T.G.M.	15 - 150 eV 0.8 - 5 keV 20 - 250 eV	EXAFS Photoemission - SR and Lasers XAS Angle-Resolved Photoemission (Solids) Photodiffraction
SA1	Normal incidence	6000-3000 A	Fluorescence (Biology)
SB1	Normal incidence		
SU2	a) 2-crystal	0.8 - 3 keV	XAS and Photoemission with Circular Polarization
(A.S. Wiggler January 1990)	b) 10m T.G.M.	0.1 - 1 keV	
SA2	2-crystal	0.8 - 5 keV	XAS - XANES - Photoemission
SB2	T.G.M.	20 - 150 eV	Photoemission (Atomic Physics) - SR and Lasers
SU3 resolution (undulator) (July 1990)	Plane-grating	10 - 300 eV	Very High Angle-Resolved Photoemission
SA3	a) 2-crystal b) Plane-grating	0.8 - 5 keV 10 - 300 eV	High resolution spectroscopy (molecular physics)
SA4		6000 - 2000 A	Time Resolved Fluorescence (Phase and Modulation)
SB4		6000 - 2000 A	Time Resolved Fluorescence (Phase and Modulation)

Table 9. D.C.I.

Line Type	Monochromator Photon Energy Range in Å	Resolution ($\Delta\lambda/\lambda$)	Experiment
D11 Bent-Crystal	0.4 - 3Å	10^{-4}	Dispersive EXAFS
D13 2-Crystal	0.4 - 3Å	10^{-4}	EXAFS
D13 2-Crystal	0.4 - 3Å	10^{-4}	SEXAFS
D14 Curved-Crystal	0.6 - 4Å	10^{-2}	X-Ray Fluorescence
D15 Multiple (S-5) Reflections	0.4 - 3Å	10^{-4}	Standing Waves
D16 Curved-Crystal	0.9 - 2.1Å	$4x10^{-3}$	X-Ray Diffraction
D21 2-Crystal	0.4 - 2Å	10^{-4}	EXAFS, Reflexafs
D22 2-Crystal	0.8 - 3Å	10^{-4}	Small-Angle Scattering
D23 2-Crystal (Sagittal Focusing)	1.0 - 2.4Å	10^{-4}	Diffuse and Anomalous Scattering
D24 Curved-Crystal	1.0 - 2.0Å	10^{-3}	Small-Angle Scattering
D25 Channel-Cut and White Beam	1.0 - 2.4Å	10^{-4}	X-ray Topography
Channel-Cut	1.24Å	10^{-6}	
D25 Channel-Cut	0.8 - 2Å	10^{-4}	Surface Diffraction
D41 Curved-Crystal	1.2 - 1.8Å	$4x10^{-3}$	Protein Diffraction
D42 Channel-Cut	0.4 - 2Å	10^{-4}	EXAFS
D43 Curved-Crystal	1.2 - 1.8Å	$4x10^{-3}$	Protein Diffraction
D44 2-Crystal	0.4 - 2Å	10^{-4}	EXAFS
D45 2-Crystal	0.6 - 2Å	10^{-4}	Diffuse Scattering (2-Circle)
W_1 (Wiggler)			
W_{32} 2-Crystals (Sagittal Focusing)	0.3 - 2Å	10^{-4}	Compton Scattering and Diffuse Scattering (2-Circle)
W_{22} 2-Crystals (Sagittal Focusing)	0.4 - 3.0Å	10^{-4}	4-Circle Diffractometer (89)
W_{21} 2-Crystal (Sagittal Focusing)	0.5 - 3.0Å	10^{-4}	Surface EXAFS (end 89)
W_{32} Curved Crystal	0.5 - 2Å	$4x10^{-3}$	Protein Diffraction and Diffuse Scattering (end 89)

In addition about 900 users come every year (25 percent from the rest of Europe and overseas). In 1990, 490 projects have been submitted (33 percent in chemistry, 20 percent in biology, 42 percent in physics, and others 5 percent).

Proposals for beam time are submitted biannually (December) and are subject to peer review. There is no charge for beam time excepted for proprietary research.

The storage rings operate each week from Monday 8 AM to Saturday 4 AM (16 hours daily).

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Synchrotron Radiation Source
SERC Daresbury Laboratory, Warrington, United Kingdom

The Synchrotron Radiation Source (SRS) was the world's first high-energy electron accelerator dedicated to producing and utilizing synchrotron radiation. The SRS is located at the Daresbury Laboratory, near Warrington, Cheshire, England, and is operated by the U.K. Science and Engineering Research Council (SERC).

The SRS is a 2-GeV electron storage ring, with 16 dipole bending magnets, from which intense beams of electromagnetic radiation (spanning a wavelength range from x rays to IR) are extracted and fed to some 30 experimental stations. The storage ring is equipped with wigglers and undulators that produce enhanced radiation fluxes in the hard and soft x-ray regions, respectively. Standard equipment provided at the stations usually includes:

- Monochromator
- Sample chamber
- Detector
- Data acquisition electronics.

Facilities exist for:

- EXAFS
- X-ray diffraction and scattering
- X-ray imaging surface science studies
- Time-resolved spectroscopy
- Atomic and molecular spectroscopy.

The 25 fully operational stations consist of:

- 4 each for EXAFS and angle-resolved photoelectron spectroscopy
- 2 each for protein crystallography, small-angle scattering, powder diffraction, x-ray topography, and soft x-ray spectroscopy
- 1 each for:
  - time-resolved x-ray diffraction and surface EXAFS
  - Surface x-ray diffraction
  - Energy dispersive x-ray diffraction
  - Photoionization mass spectroscopy
  - High-resolution molecular spectroscopy
  - Fluorescent lifetime/time-resolved spectroscopy.

The five stations that are nearing operational status include 1 each for:

- Angle-resolved photoemission
- SXR microscopy
- Materials science
- Protein crystallography
- IR spectroscopy.

Several more stations will be installed during the period 1990-1995.

The majority of users come from U.K. academic institutions, but there is increasing use by scientists from other places: U.K. industrial companies, overseas laboratories (mainly academic) in Europe, and the U.S. Special agreements exist between the SERC, the Netherlands, Sweden, and Spain to provide beamtime in return for cash or investment in kind in the SRS. Access arrangements depend on user affiliation; U.K. academics should apply to SERC for grants. Awarding of grants is based on peer review. Nonacademics and proprietary work are normally subject to beamtime charges and no peer review is required. Overseas academics not covered by special agreements are subject to peer review. Beamtime charges may be waived on grounds of reciprocal access by U.K. scientists to comparable facilities in the applicant's country or based on scientific merit.

The SRS operates on a 24-hour day for several weeks at a time, typically providing over 5,000 scheduled user hours annually. Beamtime Allocation Panels schedule beamtime biannually in 6-month blocks.

Ancillary laboratories at Daresbury include the Biology Support Laboratory and the Materials Science Laboratory. Staff scientists also provide support in running the experimental stations, and aiding with data analysis. An industrial liaison unit--Daresbury Research Services--promotes commercial use of the SRS. The laboratory normally accepts short-term visitors, but is also able to accept longer-term visiting scientists.

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